TECHNICAL MANUAL

OPERATION and MAINTENANCE

FIXED FREQUENCY OSCILLATORS

ONE, TWO, and THREE PHASE

0.1% FREQUENCY ACCURACY

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behlman division

CALIFORNIA INSTRUMENTS CORPORATION

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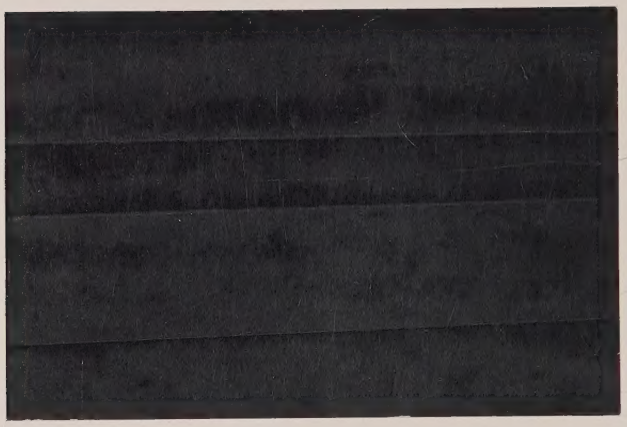

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REV. APRIL, 1964

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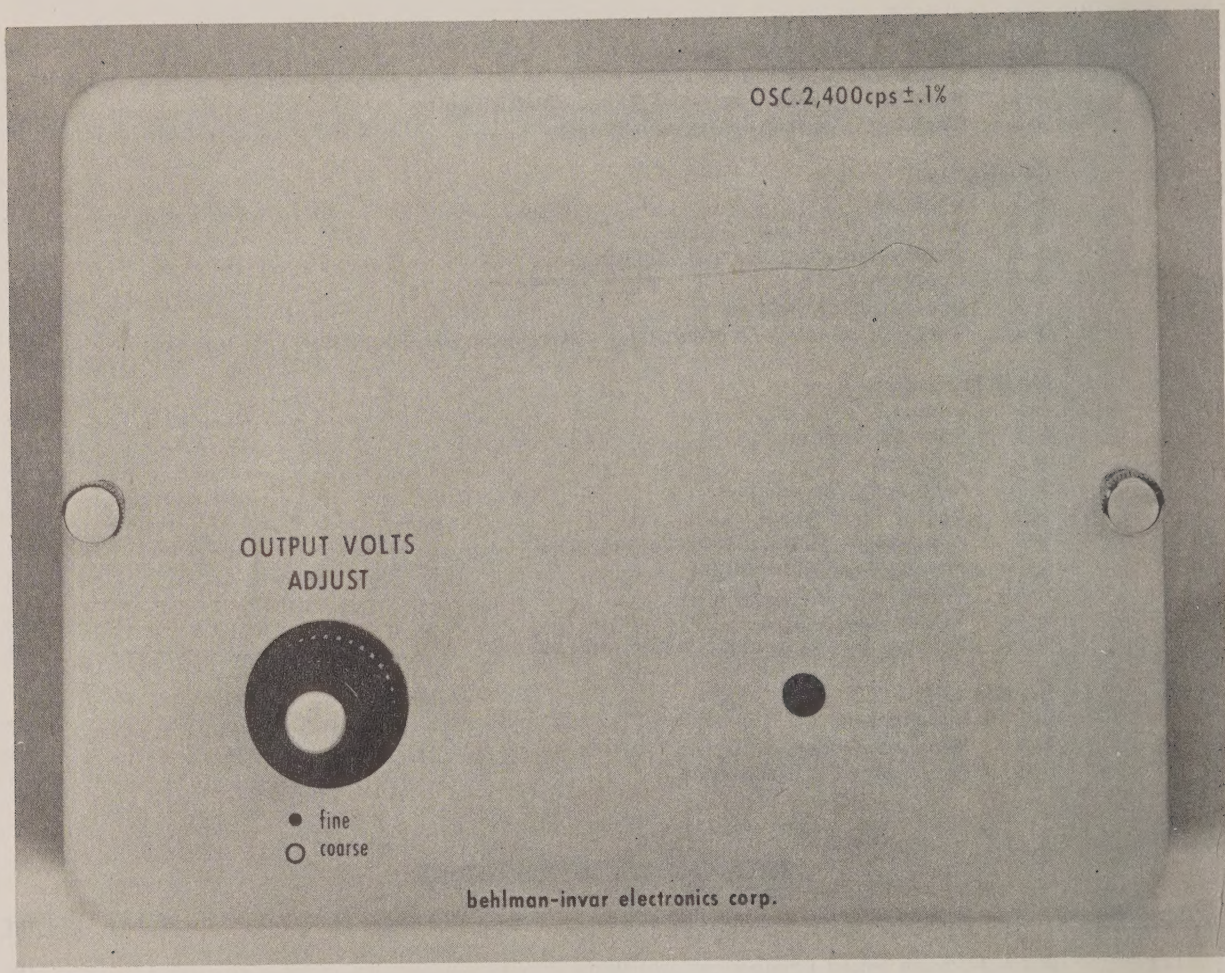


Figure 1-1. 0.1% 2-Phase Fixed Frequency Oscillator

SECTION 1
INTRODUCTION AND SPECIFICATIONS

1-1. IDENTIFICATION AND GENERAL DESCRIPTION

1-2. This manual provides a general description, theory of operation, and operating and maintenance instructions for all Behlman-Invar Fixed Frequency, 0.1% 1-, 2- and 3-phase Plug-In Oscillators (see Figure 1-1). This manual also contains related schematics for all of the various models and frequencies.

1-3. The basic electrical design of all models is essentially identical. The principal circuit differences between models are in the phase-shift networks of the 2- and 3-phase oscillators. Essential circuits of each of the Fixed Frequency Plug-In Oscillators include a Wien bridge oscillator and two cascaded cathode followers that provide both output and feedback signals. In the case of the 2-phase and 3-phase oscillators, the additional phases are produced by phase shift circuits associated with the Wien bridge oscillators of these units. D-c voltages for the operation of the Wien bridge oscillator and phase shift circuits are provided by the Invertron power supply in which the Fixed Frequency Plug-In Oscillator is used.

1-4. SPECIFICATIONS AND PERFORMANCE DATA

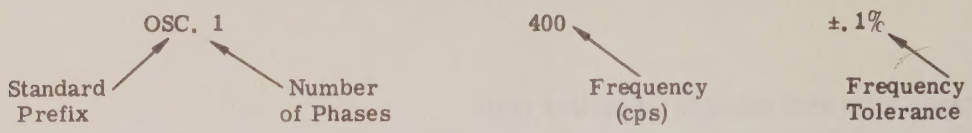
1-5. Refer to Table 1-1 for specifications and performance data.

TABLE 1-1. SPECIFICATIONS AND PERFORMANCE DATA

Electrical Specifications	
Typical Frequencies Available for 1-, 2- and 3-Phase Oscillators	60, 100, 120, 200, 240, 400, 500, 800, 1000, 2000, and 4000 cps
Frequency Accuracy	±0.1%
Maximum Output	15 volts rms
Output Noise	60 db below full output
Distortion	0.2%
Power Requirements	-105 volts dc and +300 volts dc (both electronically regulated), and 6.3 volts ac.
Mechanical Specifications	
(Designed to fit standard oscillator compartments of all Invertron power supplies.)	
Chassis:	
Height	4.15 inches
Width	5.53 inches
Depth	7.46 inches
Front Panel:	
Height	5.15 inches
Width	6.77 inches
Weight	4 lbs. max.

1-6. ESTABLISHMENT OF OSCILLATOR MODEL NUMBER

1-7. The oscillator model numbers are composite numbers which reflect the electrical characteristics of the related oscillators in the following manner:



SECTION 2
CIRCUIT DESCRIPTION

2-1. GENERAL FUNCTIONAL DESCRIPTION. (See Figures 2-1 and 4-1 through 4-4.)

2-2. The Wien bridge oscillator develops the operating frequency of the oscillator unit. The first of two cascaded cathode follower stages provides feedback inputs to the Wien bridge circuit and also drives the second cathode follower, which functions as the oscillator output stage. In the 1-phase oscillator, the output cathode follower signal constitutes the end, 1-phase, output of the oscillator. To maintain the required phase displacement in the 2- and 3-phase oscillators, the phase B and C voltages are developed from the phase A voltage. To produce the phase C output, a portion of the phase A signal is effectively shifted in phase by 120° and made equal in amplitude to the phase A output voltage. In the case of the 3-phase units, the phase C voltage is applied to the output connector and is also employed in conjunction with the phase A voltage to produce the phase B voltage, which is equal in amplitude to the phase A and C voltages and displaced in phase from both by 120°. In the 2-phase units, the phase C voltage is employed solely in the development of the phase B voltage, which, in this case, is equal in amplitude to the phase A voltage and leads it in phase by 90°.

2-3. CIRCUIT DESCRIPTION

2-4. WIEN BRIDGE OSCILLATOR AND PHASE SHIFT CIRCUITS. The Wien bridge oscillator is comprised of an RC bridge circuit, amplifier stages V1A and V1B, and feedback cathode follower stage V2A. The bridge is comprised of the following elements:

a. Two legs, which form the frequency-determining circuit of the oscillator circuit and which include (1) capacitor C1 and resistor R1, and (2) resistor R2 and capacitors C2 thru C5.

b. Two legs, which form a feedback network and which include (3) thermistor RT1 and resistor R9, and (4) resistor R8.

The grid and cathode of V1A are connected to the junctions of R1 and R2, and R8 and R9, respectively. Stages V1A and V1B are conventional RC-coupled class A amplifiers that increase the oscillator output amplitude sufficiently to drive stage V2A. The synchronizing signal input is connected through R5 to the grid of V1B.

2-5. The output of V1B is coupled to the grid of cathode follower V2A through R10. The output at the cathode of V2A is applied (1) as positive feedback to the grid of V1A, via C7, C1, and R1, (2) as negative feedback to the cathode of V1A via C7, RT1, and R9, and (3) as the oscillator output signal to the grid of cathode follower V2B via a circuit that includes FINE and COARSE OUTPUT VOLTS ADJ controls R1A and R1B. Potentiometers R1A and R1B provide for (respective) fine and coarse adjustments of the amplitude of the input to V2B and, thereby, establish the output voltage level of the oscillator unit. Tube V2B provides a low-impedance output for the single-phase oscillator and the phase A output for the 2- and 3-phase oscillators. In the case of the latter oscillators, the output of V2B is applied to auxiliary phase-shifting circuits.

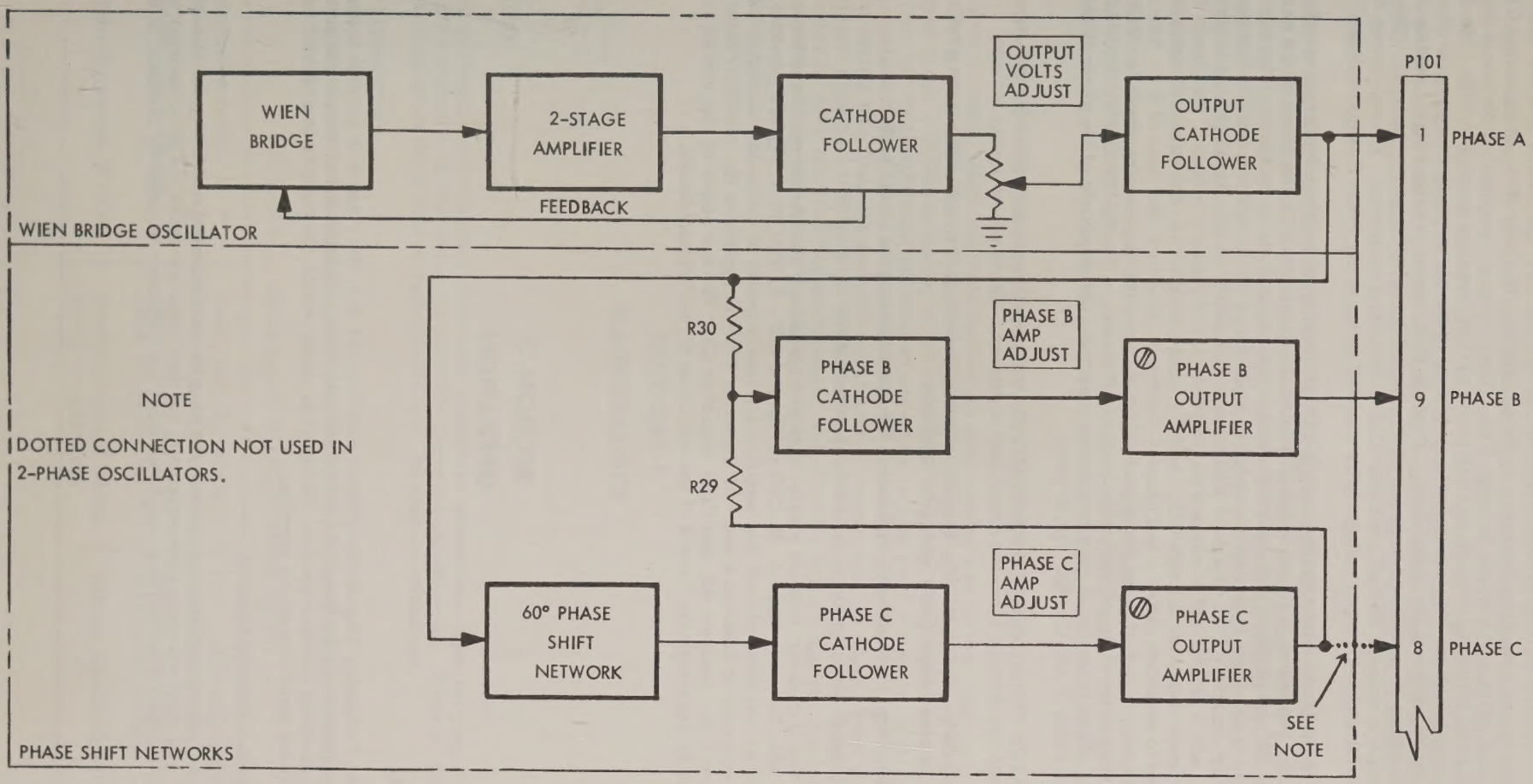


Figure 2-1. 3-Phase, 0.1%, Fixed Frequency Oscillator, Block Diagram

2-6. Phase Shift Network for 3- and 2-Phase Oscillators. The output of the single-phase circuit (phase A) is applied to the phase shifting network composed of R17 and C17, the values of which are selected with consideration to the operating frequency of the oscillator. Resistor R17 and capacitor C17 shift the input phase 60° and apply it to cathode follower V3A. The output of the cathode follower is coupled through the amplitude adjusting network and C14 to the grid of inverting amplifier V3B. The PHASE C AMP ADJUST potentiometer, R20, controls the amplitude of the signal applied to the grid of the inverting amplifier and thereby controls its output level. Pentode V3B inverts the input signal (which is 60° out of phase with the phase A signal) and makes it 120° out of phase with the phase A signal. The phase C output of this stage is coupled through capacitor C12 to the output connector. Potentiometer R20 permits the amplitude of the phase C output voltage to be adjusted to equal the phase A output voltage.

2-7. Portions of the phase A and phase C output voltages are added vectorially across matched resistors R29 and R30. The two signal voltages summed across these resistors fix the phase of the phase B signal at a point 60° out of phase with both the phase A and phase C signal voltages. The signal voltage representing this vector sum is applied to inverting amplifier V4B through the amplitude adjusting network and coupling capacitor C16. Pentode V4B inverts and amplifies the signal voltage to provide the phase B output, which is 120° out of phase with the phase A and phase C outputs. The phase B output is coupled to the output connector through C11. In the 2-phase oscillators, the values of resistors R29 and R30 are selected to establish phase A and phase C feedback voltages in the ratio of 2:1. The output representing the vector sum of these two signal voltages is applied to inverting amplifier V4B through the amplitude adjusting network associated with the phase B circuit. The PHASE B AMP ADJUST potentiometer, R31, in the phase B amplitude adjusting network permits the amplitude of the phase B output to be equated with the phase A and C output amplitudes.

2-8. OSCILLATOR OPERATING POWER CIRCUITS. All operating power inputs for the circuits of the plug-in oscillator are derived from the associated Invertron. These power inputs include:

a. +300 volts, electronically regulated, for application to the plate and screen grid circuits of the plug-in oscillator unit electron tubes

b. -105 volts, electronically regulated, for application to the phase shift circuits

c. 6.3 vac for application to the electron tube heaters

2-9. Wien Bridge Oscillator Tube DC Heater Circuit Provision. The 60-cps models of the 0.1% oscillator (OSC. 1, 60-CPS ±.1%; OSC. 2, 60-CPS ±.1%, and OSC. 3, 60-CPS ±.1%) are provided with a half-wave rectifier and filter circuit that supplies d-c heater power to oscillator-amplifier tube V1. The 6.3-volt a-c power at contacts 4 and 5 of connector P101 is applied to the rectifier/filter comprised of diode rectifier CR1, resistor R1, and filter capacitor C1. The d-c output of this circuit is applied to the heater of V1 via terminals 7 and 9 of the oscillator printed circuit board.

SECTION 3
OPERATION

3-1. GENERAL

3-2. The Fixed Frequency Plug-In Oscillators (see Figures 1-1, 4-1, and 4-2) provide frequency, phase, and output level control for all Invertron A-C Power Supplies. All versions of the oscillator are constructed using standard modular chassis, designed to mount within the receptacle provided in the front panel of each of the Invertron power supplies.

3-3. A-C AND D-C POWER INPUTS

3-4. A-c and d-c power necessary to operate the plug-in oscillator is provided by the associated Invertron power supply. All input and output connections to the oscillator are made via the connector on the rear-most portion of the oscillator and are completed when the oscillator is properly installed in the Invertron.

3-5. PRELIMINARY CHECKS AND ADJUSTMENTS

3-6. Each plug-in oscillator is shipped from the factory in proper operating condition and may be placed in immediate operation without preliminary checks and/or adjustments. In event that a new oscillator fails to operate properly in an Invertron known to be in good operating condition, refer to the appropriate portions of the warranty contained in this manual. In other cases of improper operation of the oscillator, check the associated Invertron for proper operation as indicated in the associated instruction book and, if the Invertron is operating properly, troubleshoot the oscillator as described in Section 4.

3-7. CONTROLS

3-8. The plug-in oscillator is provided with one operating control: the OUTPUT VOLTS ADJUST, control, which is a dual-concentric control mounted on the oscillator front panel. This control, which, in the case of the multiple-phase oscillators, adjusts the output levels of all phases simultaneously, consists of an outer knob and an inner knob, which provide for coarse and fine adjustment, respectively, of the oscillator output signal level.

3-9. OPERATING PROCEDURE

3-10. To place the oscillator in operation, insert it into the front panel receptacle of the associated Invertron, secure the (captive) attaching screws, and energize the Invertron. The plug-in oscillators are designed for continuous, unattended operation; therefore, there are no operating procedures for them.

3-11. USE OF FREQUENCY CONTROL INPUTS FROM EXTERNAL SOURCES

3-12. All of the 1-phase, fixed frequency oscillators are provided with a front-panel-mounted EXTERNAL OSC. INPUT jack which enables an externally derived signal to be applied, as a frequency control signal, through circuits of the oscillator, to the associated Invertron. Any sine-wave signal in the 45 through 5000 cps frequency range and with an amplitude ranging from 0 through 13 volts rms may be connected to the jack. The jack is a standard 1/4 inch, closed circuit telephone jack which, upon insertion of the mating plug from the external signal source, disconnects the output of the Wien bridge oscillator circuit from the OUTPUT VOLTS ADJUST control circuit and applies the external signal to the control circuit. As a result of this arrangement, the OUTPUT VOLTS ADJUST control circuit of the oscillator retains full control over the Invertron output voltage level.

SECTION 4
MAINTENANCE

4-1. GENERAL

4-2. Careful and regular performance of periodic preventive maintenance upon the plug-in oscillators will reduce the probability of failure and the need for corrective maintenance. Refer to Figures 4-1 thru 4-4 as aids in the performance of maintenance upon the plug-in oscillators.

4-3. TEST EQUIPMENT

4-4. Test equipment required for adjusting and troubleshooting plug-in-oscillators is listed in Table 4-1.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

NOMENCLATURE	PART NO. OR MODEL	APPLICATION
Low Frequency Oscilloscope	Hewlett-Packard Model 120B, or equivalent	Monitoring wave forms and general signal tracing
Vacuum Tube Voltmeter (VTVM)	Hewlett-Packard Model 410B, or equivalent	Voltage measurements

TABLE 4-1. RECOMMENDED TEST EQUIPMENT (continued)

NOMENCLATURE	PART NO. OR MODEL	APPLICATION
Volt-Ohm-Milliammeter (VOM)	Triplett Model 630 PL or equivalent	General voltage, current, and resistance measurements
Distortion Analyzer	Hewlett-Packard Model 330B or equivalent	Waveform distortion measurement
Frequency Counter	Beckman-Berkley Model 7360 or equivalent	Output frequency measurement
Oscillator Test Cable	Behlman-Invar Part No. 3002751	Test and alignment

4-5. CLEANING. Remove dust, dirt, and other foreign material using a small brush and vacuum cleaner. Low pressure air may be used if a vacuum cleaner is not available. When using the air, be sure to aim the air stream so that the foreign material will be blown away from the unit being cleaned, rather than into recesses, slots, etc. Use a cloth and a suitable solvent to remove material not removable by means of the above procedure.

4-6. ALIGNMENT PROCEDURE

4-7. The alignment of the oscillator should be checked and, where necessary, adjusted whenever an oscillator is suspected of malfunctioning and after repair, or replacement, of a defective component to ensure that the oscillator is operating within tolerance.

4-8. USE OF TEST BENCH CABLE. The plug-in oscillator must be removed from the Invertron power supply to provide access to its circuits during servicing. A test bench cable (Behlman-Invar Oscillator Test Cable, Part No. 3002751) is available for the purpose of maintaining the electrical connections between the Invertron oscillator-receptacle connector and the oscillator plug, with the oscillator removed from the Invertron.

4-9. ADJUSTMENT OF OSCILLATOR OUTPUT LEVEL. Proceed as follows:

1. Connect the VTVM between pins 1 and 2 of connector P101 (1-, 2- and 3-phase oscillators).
2. Rotate the OUTPUT VOLTS ADJUST COARSE and FINE controls clockwise until the meter reads 13 volts rms.
3. Disconnect the VTVM, then connect the frequency counter input cable between pins 1 and 2 of the output connector. Adjust counter for a stable and repeating count.
4. After allowing the oscillator and counter to reach operating temperature, adjust the oscillator trimmer capacitor C2 until the counter indicates that the oscillator is producing the required output signal frequency. Disconnect the counter.
5. Connect the VTVM between P101 pins 2 and 8 (3-phase oscillator only). Adjust R20 until the phase C output reads 13 volts rms.
6. For 2-phase oscillators only, connect the meter between pin 2 of P101 and pin 9 of V3, then adjust R20 for a phase C output of 13 volts.
7. Connect the meter between pins 2 and 9 of P101 (2- and 3-phase oscillators) and a phase B output of 13 volts rms.

4-10. PHASE ANGLE ADJUSTMENT. Proceed as follows:

1. Phase angle may be checked by measuring the line-to-line voltages for all phase combinations. When line-to-neutral readings are 13 volts, the line-to-line voltage will be 22.5 volts in each combination. (Note that the phase angles may be more accurately determined

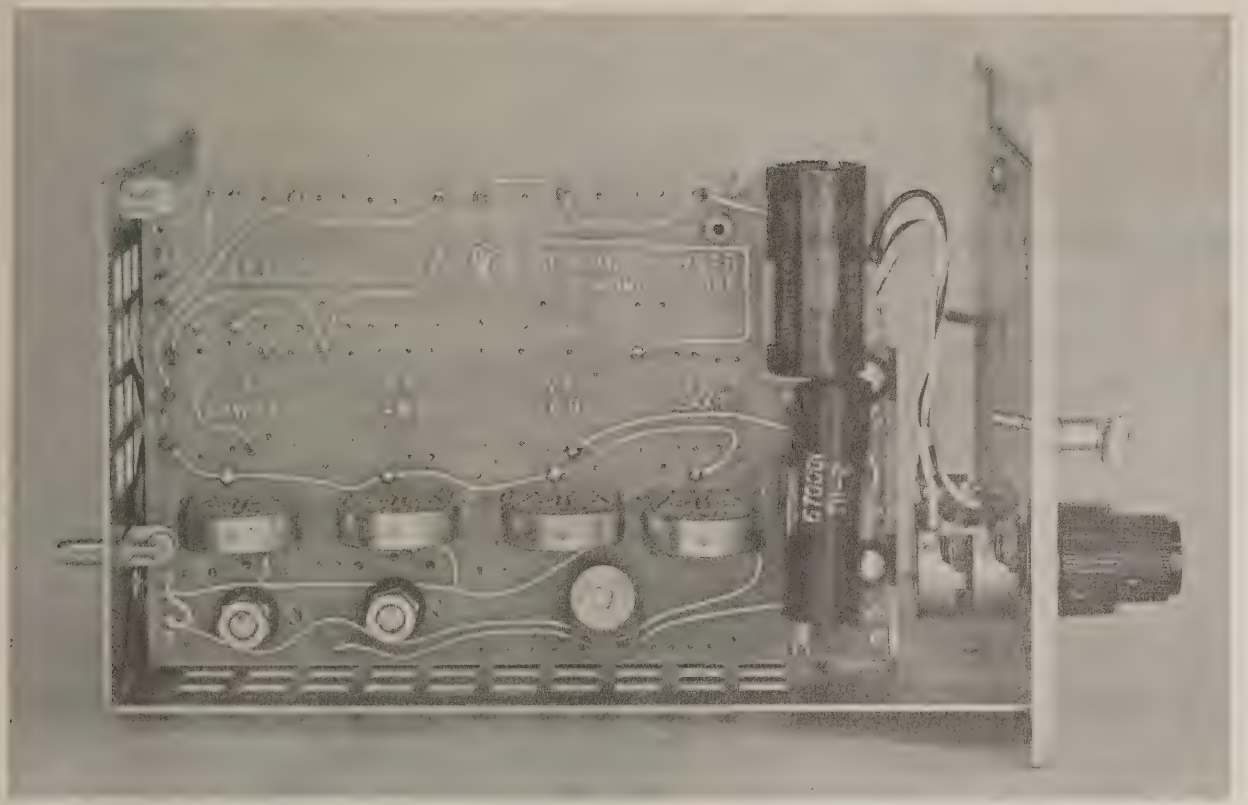


Figure 4-1. 2-Phase, 400-CPS ±0.1% Oscillator, Left Side

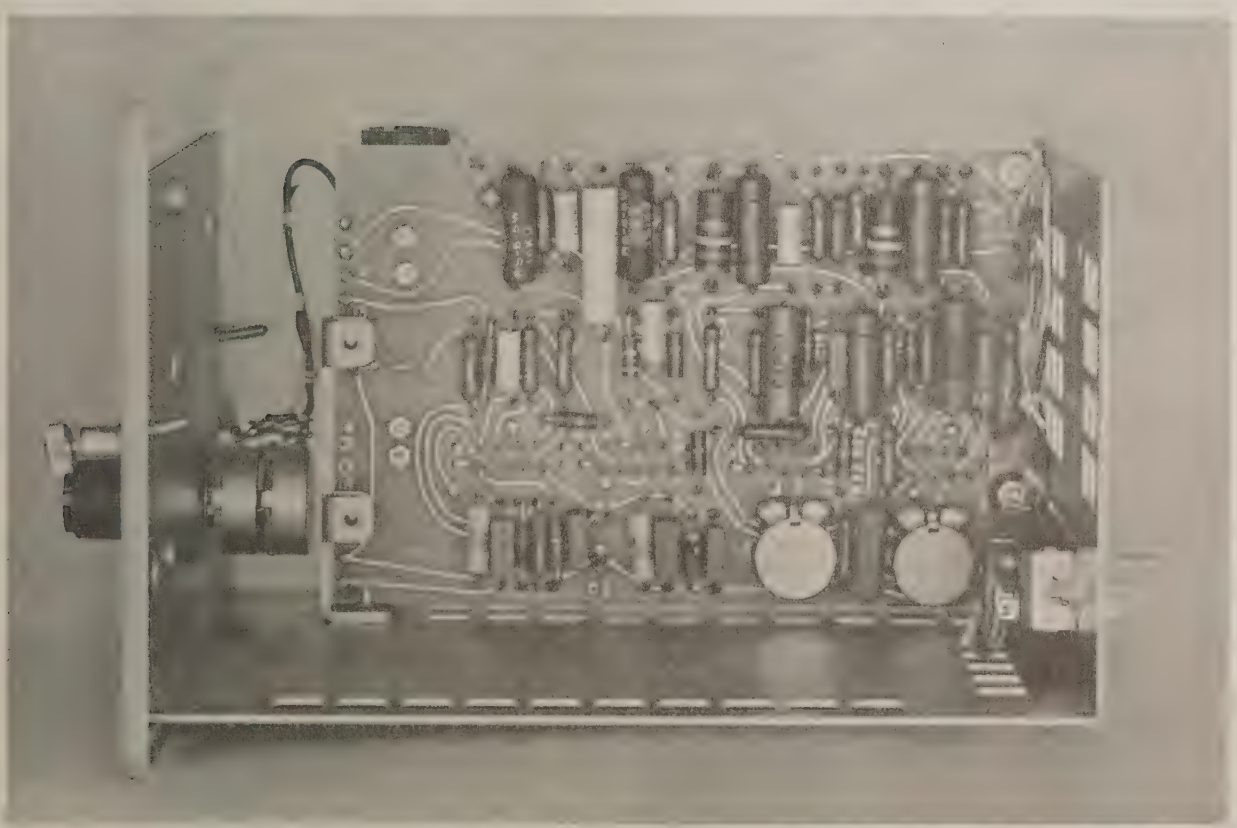


Figure 4-2. 2-Phase, 400-CPS ±0.1% Oscillator, Right Side

by the use of an oscilloscope. Alternately connect all phase combinations to identically calibrated horizontal and vertical amplifiers to obtain the correct Lissajous pattern for the angles being measured.)

2. Alternately adjust R20 and R31 to achieve an accurate phase relationship. (Note that the values of resistors R9 and R16 are selected to exactly suit the circuit conditions and thereby enable precision operation.)

4-11. DISTORTION MEASUREMENTS. Proceed as follows:

1. Connect distortion meter between each line and ground.

2. Distortion must be less than 0.2% for each line.

3. If distortion is greater than 0.2%, check troubleshooting chart.

4-12. TROUBLESHOOTING

4-13. Troubleshooting techniques conventionally employed with both electron tube-type and solid-state power supplies and audio amplifiers are appropriate for this equipment. Table 4-2, Troubleshooting Chart, presents a group of typical malfunction symptom/remedial action patterns. The chart is a general guide that is structured to help in isolating the trouble to a given stage or component of a stage.

4-14. VOLTAGE AND RESISTANCE MEASUREMENTS. Table 4-3 lists typical voltage and resistance measurements obtained between each tube socket terminal and chassis ground; however, the measurements made upon any given oscillator may produce indications that may differ to some extent from the values shown. Therefore, it is recommended that, upon receipt of an oscillator, the measurements given in Table 4-3 be duplicated and the values recorded. The voltage measurements listed in Table 4-3 were taken under the following conditions: oscillator in normal operating condition, connected to Invertron power supply by test bench cable, and supplying 13 volts on each phase line.

4-15. Resistance Check of Thermistor RT1. Thermistor RT1 has a normal "hot", or operating, resistance of 50k ohms and a cold resistance of approximately 5 megohms. It is impracticable to measure the hot resistance of RT1. However, when making continuity checks, do not consider RT1 to be open unless it has been checked with an ohmmeter capable of measuring 5 megohms and then demonstrated to be open.

TABLE 4-2. TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSE	ACTION
Single-Phase Oscillator		
No output	Defective tube. Defective EXTERNAL OSC INPUT jack. Defective capacitor C7.	Replace tubes as required. Replace jack. Replace C7.
Low output	Defective tube. Defective output potentiometer.	Replace tubes as required. Replace potentiometer.
Excessive waveform distortion	Defective tube. Defective component in thermistor leg of Wien bridge.	Replace tubes as required. Determine faulty components and replace as required.
Signal frequency unstable	Intermittent Wien bridge component.	Determine faulty component and replace as required.
Signal frequency too high or too low	Defective Wien bridge component.	Determine faulty component and replace as required.

TABLE 4-2. TROUBLESHOOTING CHART (continued)

SYMPTOM	PROBABLE CAUSE	ACTION
2- and 3-Phase Oscillators		
No output, all phases	Defective tube. Defective EXTERNAL OSC Input Jack J1.	Replace defective tube(s) as required. Replace defective jack J1.
No output, phase B and/or phase C	Defective tube. Defective resistor R7, C7 Potentiometers R20, R31.	Replace defective tubes as required. Determine defective component and replace as required.
Low output, all phases	Defective tube.	Replace defective tubes as required.
Low output, phase C and/or phase C	Defective tube. Defective phase shift components. Incorrect phase shift.	Replace defective tubes as required. Determine defective component and replace as required. Determine actual phase and correct as necessary.
Incorrect phase shift, phase C	Incorrect oscillator frequency. Faulty phase shift network.	See alignment procedure. Determine fault and replace defective components.
Incorrect phase shift, phase B	Incorrect phase C or phase A output amplitude	See alignment procedure.
High waveform distortion	Defective tube. Defective component in thermistor leg of Wien bridge.	Replace detective tubes as required. Determine faulty components and replace as required.
Signal frequency unstable	Intermittent Wien bridge component.	Determine defective component and replace.
Signal frequency high or low	Defective Wien bridge component.	Determine defective component and replace.

TABLE 4-3. TUBE SOCKET TERMINAL VOLTAGE AND RESISTANCE MEASUREMENTS

Printed Circuit Board Assemblies 4002150-2 (OSC. 1), 4002152-2 (OSC. 2), and 4002149-2 (OSC. 3)			
TUBE TYPE AND REF. DES.	SOCKET TERM. NUMBER	VOLTAGE	RESISTANCE
12AX7	1	225 VDC	250 K
V1	2	Osc. stops when measured	750 K
(OSC. 1, 2, 3)	3	2.4 VDC	10 K
	4	6.3 VDC (heater)	2 Ω
	5	6.3 VDC (heater)	2 Ω
	6	125 VDC	250 K

TABLE 4-3. TUBE SOCKET TERMINAL VOLTAGE AND RESISTANCE MEASUREMENTS (continued)

TUBE TYPE AND REF. DES.	SOCKET TERM. NUMBER	VOLTAGE	RESISTANCE
	7	Osc. stops when measured	1 M
	8	0.5 VDC	700Ω
	9	Filament Center Tap	
5687	1	275 VDC	32 K
V2	2	Osc. stops when measured	2 M
(OSC. 1, 2, 3)	3	140 VDC	10 K
	4	6.3 VAC (heater)	2Ω
	5	6.3 VAC (heater)	2Ω
	6	130 VDC	10 K
	7	Osc. stops when measured	250 K
	8	Filament Center Tap	
	9	275 VDC	32 K
6AW8	1	145 VDC	40 K
V3	2	140 VDC	68 K
(OSC. 2, 3)	3	275 VDC	32 K
	4	6.3 VAC (heater)	2Ω
	5	6.3 VAC (heater)	5Ω
	6	GND	1Ω
	7	125 VDC	1 M
	8	60 VDC	25 K
	9	115 VDC	60 K
6AW8	1	145 VDC	40 K
(OSC. 2, 3)	2	125 VDC	600 K
	3	275 VDC	32 K
	4	6.3 VAC (heater)	2Ω
	5	6.3 VAC (heater)	6Ω
	6	GND	1Ω
	7	-0.5 VDC	1 M
	8	65 VDC	25 K
	9	145 VDC	48 K

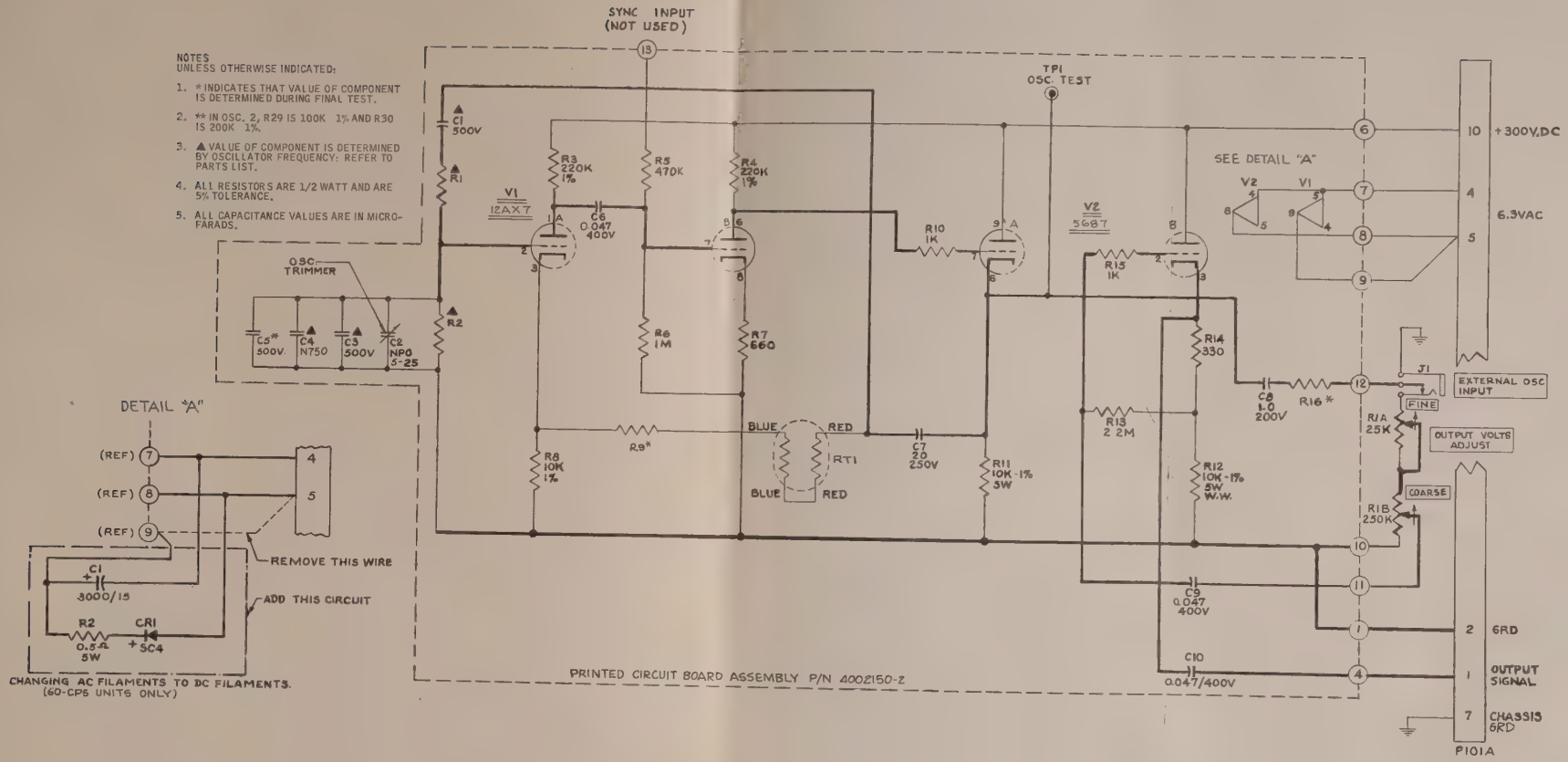
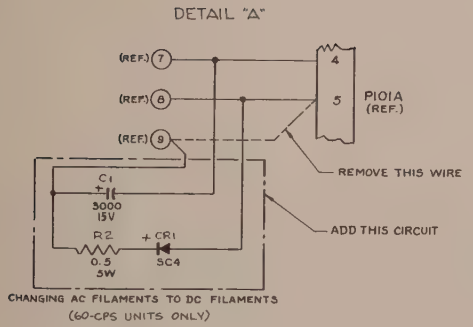


Figure 4-3. 1-Phase, 0.1% Oscillator, Schematic Diagram

NOTES
UNLESS OTHERWISE INDICATED:

1. * INDICATES THAT VALUE OF COMPONENT IS DETERMINED DURING FINAL TEST.
2. ** IN OSC. 2, R29 IS 100K 1% AND R30 IS 200K 1%.
3. ▲ VALUE OF COMPONENT IS DETERMINED BY OSCILLATOR FREQUENCY: REFER TO PARTS LIST.
4. ALL RESISTORS ARE 1/2 WATT AND ARE 5% TOLERANCE.
5. ALL CAPACITANCE VALUES ARE IN MICROFARADS.



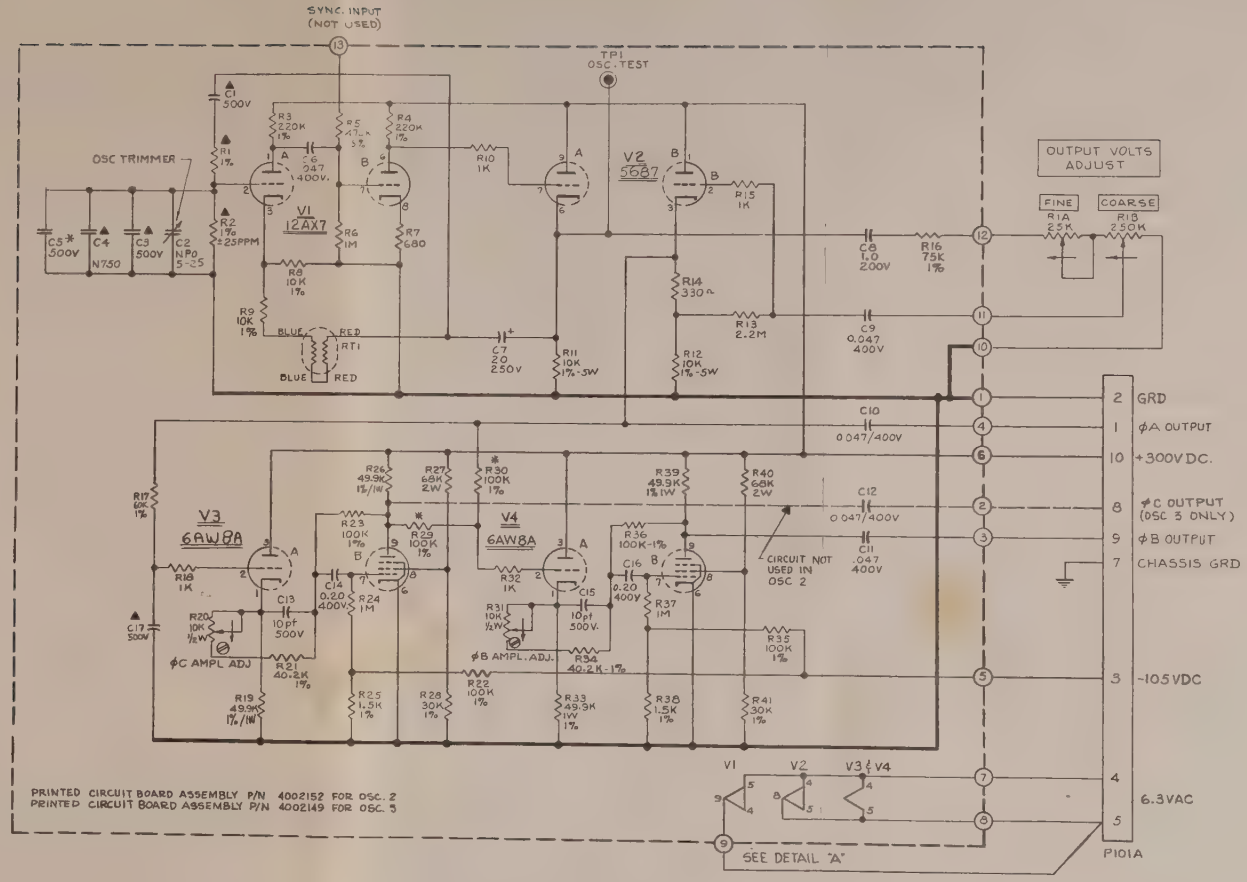


Figure 4-4. 2- and 3-Phase, 0.1% Oscillators, Schematic Diagram

SECTION 5
PARTS LISTS

5-1. INTRODUCTION

5-2. This section provides the information necessary for procuring replacements for all electrical parts of the Fixed Frequency, 1-, 2-, and 3-Phase, 0.1% Oscillators. The components tabulated in the parts list are grouped by assembly, and arranged in each assembly in alpha-numerical sequence according to reference designations.

5-3. VENDORS' CODES. With the exception of item "LZ" in the following tabulation, approved vendors' codes, as listed in Federal Cataloging Handbook H4-1, are used in the parts lists and are listed below in numerical sequence.

CODE	VENDOR'S NAME AND ADDRESS
00656	Aerovox Corp. New Bedford, Mass.
02799	Arco Capacitors, Los Angeles, Calif.
04746	Behlman-Invar Elect. Corp. Santa Monica, Calif.
05162	Erie Resistor Corp. Hawthorne, Calif.
06228	Texas Instruments, Inc. Dallas, Texas
14099	Semtech Corp. Newberry Park, Calif.
14655	Cornell-Dubilier Elect. Corp. Newark, New Jersey
44655	Ohmite Mfg. Co. Skokie, Illinois
65092	Weston Instruments Div. of Daystrom, Inc. Los Angeles, Calif.
71590	Centralab Electronics Milwaukee, Wisc.
71785	Cinch Mfg. Co. Div. of United Carr Fastener Corp. Chicago, Illinois
81095	Raytheon Mfg. Co. Industrial Apparatus Div. Los Angeles, Calif.
86797	Rogan Bros. Skokie, Illinois
91637	Dale Products, Inc. Columbus, Nebraska
91662	Elco Corp. Philadelphia, Penna.
LZ	Texas Research and Elect. Corp. Dallas, Texas

5-4. OSCILLATOR CONFIGURATIONS

5-5. Since there are so many configurations of the subject oscillators, the parts lists are divided into two groups to facilitate location of specific parts of any of the oscillators. These groups are: Table 5-1, Parts List for OSC. 1, 400-CPS ±.1%; and Table 5-2, Parts List for OSC. 2 and OSC. 3, 400-CPS ±.1%. In each table, all applicable parts of the 400-cps configurations of the noted oscillators are listed; those parts that distinguish each of the 60-, 100-, 120-, 200-, 240-, 500-, 800-, 1000-, 2000-, and 4000-cps models of the oscillators being listed under "Parts Peculiar" headings following the 400-cps unit parts tabulations. Where there are differences in component values and/or quantities between the OSC. 2 and OSC. 3 units, such differences are indicated in Table 5-2 by means of "(OSC. 2 only)" and "(OSC. 3 only)" notations in the "REF DES" column immediately preceding the reference designations of the affected parts. In those cases where no reference designation has been assigned to a part, either of the above notations will appear in the REF DES column adjacent to the parts.

TABLE 5-1. PARTS LIST FOR OSC. 1, 400-CPS ±.1%

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		NOTE Asterisk (*) in REF DES column indicates that component is peculiar to the 400-cps oscillator and that the value of the component or its quantity may change from one oscillator to another as indicated in the "PARTS PECULIAR" tabulation contained in the rear portion of this table.		
	4002191-2	Main Assy, Osc. 1, 400-cps ±.1%	1	04746
V1	C-12A	. JACK, TELEPHONE, 3-circuit, closed circuit	1	71590
P101	RM 11420-1-1414-1P	. CONNECTOR, RECEPTACLE, ELECTRICAL	1	91662
R1	2001272	. POTENTIOMETER, COMP, DUAL CONCENTRIC, inner shaft element 25k ohms ±20%, 1w; outer shaft element 250k ohms ±20%, 1w . . .	1	04746
V1	12AX7	. ELECTRON TUBE	1	Any Std RETMA tube
V2	5687	. ELECTRON TUBE	1	Any Std RETMA tube
XR1	RB-999-700	. KNOB, CONTROL, CONCENTRIC	1	86797
	4002150-2	. PRINTED CIRCUIT BOARD ASSY (See breakdown below)	1	04746
	4002150-2	Printed Circuit Board Assy	REF	04746
C1*	CM15E-501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C2	557-F	. CAPACITOR, VARIABLE, 5-25 pf, NPO .	1	05162
C3*	CM15E-391J	. CAPACITOR, FXD, MICA, 300 pf ±5%, 500 wvdc	1	02799
C4*	831X5R240K	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	05162
C5		. CAPACITOR, FXD, CERAMIC, (value determined by test)	1	
C6, C9, C10	DMM473420	. CAPACITOR, FXD, PLASTIC, 0.047 µf ±20%, 400 wvdc	4	LZ
C7	BR20-250	. CAPACITOR, FXD, ELEC, 20 µf, 250 wvdc	1	14655
C8	DMM105220	. CAPACITOR, FXD, PLASTIC, 1.0 µf ±20%, 200 wvdc	1	LZ
R1*, R2*	9855-4A-750K ±25PPM-1%	. RESISTOR, FXD, FILM, 750k ohms, ±1%, 1/2w	2	65092
R3, R4	CD1/2MR-220K	. RESISTOR, FXD, FILM, 220k ohms, ±1%, 1/2w	2	06228
R5		. RESISTOR, FXD, COMP, 470k ohms ±5%, 1/2w	1	44655
R6		. RESISTOR, FXD, COMP, 1 megohm ±10%, 1/2w	3	44655

TABLE 5-1. PARTS LIST FOR OSC. 1, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
R7		. RESISTOR, FXD, COMP, 680 ohms ±10%, 1/2w	1	44655
R8	CD1/2MR-10K	. RESISTOR, FXD, FILM, 10k ohms ±1%, 1/2w	1	06228
R9		. RESISTOR, FXD, FILM, (value determined by test)	1	06228
R10, R15		. RESISTOR, FXD, COMP, 1k ohms ±10%, 1/2w	2	44655
R11, R12	RH-5-10K	. RESISTOR, FXD, WW, 10k ohms ±1%, 5w	2	91637
R13		. RESISTOR, FXD, COMP, 2.2 megohms ±10%, 1/2w	1	44655
R14		. RESISTOR, FXD, COMP, 330 ohms ±10%, 1/2w	1	44655
R16		. RESISTOR, FXD, FILM (value determined by test)	1	06228
RT1	67001	. RESISTOR, THERMAL	1	04746
TP1	276-1564-G4	. JACK, TIP, red	1	81095
XV1, XV2	RA9A	. SOCKET, ELECTRON TUBE	4	00656
	3002112	. PRINTED CIRCUIT BOARD	1	04746

PARTS PECULIAR TO OSC. 1, 60-CPS ±.1%

NOTE

** indicates that component is part of tube V1 filament d-c power circuit provided in 60-cps model of oscillator only.

	4002191-1	Main Assy	1	04746
C1**	BR-3000-15	. CAPACITOR, FXD, ELEC, 3000 μf, 15 wvdc	1	14655
CR1**	SC-4	. SEMICONDUCTOR DEVICE, DIODE	1	14099
R2**	RH-5-0.5	. RESISTOR, FXD, WW, 0.5 ohm ±3%, 5w	1	91637
	4002150-1	Printed Circuit Board Assy	1	04746
C1	CM20E-502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E-392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf, N750	1	00656
R1, R2	9855-4A-499K ±25PPM-1%	. RESISTOR, FXD, FILM, 499K ohms ±1%, 1/2	1	65092

PARTS PECULIAR TO OSC. 1, 100-CPS ±.1%

	4002191-7	Main Assy	1	04746
	4002150-7	P.C.B. Assy, Main Oscillator	REF	04746

TABLE 5-1. PARTS LIST FOR OSC. 1, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 1, 100-CPS ±.1% (continued)		
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf N750	1	00656
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 120-CPS ±.1%		
	4002191-8	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf, N750	1	00656
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 200-CPS ±.1%		
	4002191-9	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf N750	1	00656
R1, R2	9855-4A-147K ±25PPM-1%	. RESISTOR, FXD, FILM, 147k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 240-CPS ±.1%		
	4002191-10	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf N750	1	00656

TABLE 5-1. PARTS LIST FOR OSC. 1, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 1, 240-CPS ±.1% (continued)		
R1, R2	9855-4A-124K ±25PPM-1%	. RESISTOR, FXD, FILM, 124k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 500-CPS ±.1%		
	4002191-11	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ240G	. CAPACITOR, FXD, CERAMIC, 24 pf N750	1	00656
R1, R2	9855-4A-590K ±25PPM-1%	. RESISTOR, FXD, FILM, 590k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 800-CPS ±.1%		
	4002191-3	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	831XR5240K	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	05162
R1, R2	9855-4A-374K ±25PPM-1%	. RESISTOR, FXD, FILM, 374k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 1000-CPS ±.1%		
	4002191-4	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21J240G	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	00656
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 2000-CPS ±.1%		
	4002191-6	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746

TABLE 5-1. PARTS LIST FOR OSC. 1, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 1, 2000-CPS ±.1% (continued)		
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ240G	. CAPACITOR, FXD, CERAMIC, 24 pf N750	1	00656
R1, R2	9855-4A-150K ±25PPM-1%	. RESISTOR, FXD, FILM, 150k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 1, 4000-CPS ±.1%		
	4002191-12	Main Assy	1	04746
	4002150-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E101J	. CAPACITOR, FXD, MICA, 100 pf ±5%, 500 wvdc	1	02799
C3	CM15E820J	. CAPACITOR, FXD, MICA, 82 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ500G	. CAPACITOR, FXD, CERAMIC, 5 pf, N750	1	00656
R1, R2	9855-4A-374K ±25PPM-1%	. RESISTOR, FXD, FILM, 374K ±1%, 1/2w	2	65092

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1%

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		NOTE Asterisk (*) in REF DES column indicates that component is peculiar to the 400-cps oscillator and that the value of the component or its quantity may change from one oscillator to another as indicated in the "PARTS PECULIAR" tabulations contained in the rear portion of this table.		
	4002192-2	Main Assy, Osc. 2, 400-cps ±.1%	1	04746
	4002193-2	Main Assy, Osc. 3, 400-cps ±.1%		
P101	RM 11420-1-1414-1P	. CONNECTOR, RECEPTACLE, ELECTRICAL	1	91662
R1	2001272	. POTENTIOMETER, COMP, DUAL CONCENTRIC, inner shaft element 25k ohms ±20%, 1w; outer shaft element 250k ohms ±20%, 1w	1	04746
V1	12AX7	. ELECTRON TUBE	1	Any Std RETMA tube
V2	5687	. ELECTRON TUBE	1	Any Std RETMA tube
V3, V4	6AW8A	. ELECTRON TUBE	2	Any Std RETMA tube
XR1	RB-999-700	. KNOB, CONTROL, CONCENTRIC	1	86797
	4002152-2	. PRINTED CIRCUIT BOARD ASSY, 2-PHASE OSCILLATOR (See breakdown below)	1	04746
	4002149-2	. PRINTED CIRCUIT BOARD ASSY, 3-PHASE OSCILLATOR (See breakdown below)	1	04746
	4002152-2	Printed Circuit Board Assy, 2-Phase Oscillator	REF	04746
	4002149-2	Printed Circuit Board Assy, 3-Phase Oscillator	REF	04746
C1*	CM15E-501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C2	557-F	. CAPACITOR, VARIABLE, 5-25 pf, NPO	1	05162
C3*	CM15E-391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4*	831X5R240K	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	05162
C5		. CAPACITOR, FXD, CERAMIC, (value determined by test)	1	
(OSC. 2 only)				
C6, C9, C10 C11	DMM473420	. CAPACITOR, FXD, PLASTIC, 0.047 μf ±20%, 400 wvdc	4	LZ

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
(OSC. 3 only)				
C6, C9, C10, C11, C12	DMM473420	CAPACITOR, FXD, PLASTIC, 0.047 μf ±20%, 400 wvdc	5	LZ
C7	BR20-250	CAPACITOR, FXD, ELEC, 20 μf 250 wvdc	1	14655
C8	DMM105220	CAPACITOR, FXD, PLASTIC, 1.0 μf ±20%, 200 wvdc	1	LZ
C13, C15	CM15C100J	CAPACITOR, FXD, MICA, 10 pf ±5%, 500 wvdc	2	02799
C14, C16	DMM204420	CAPACITOR, FXD, PLASTIC, 0.20 μf ±20%, 400 wvdc	2	LZ
C17*	CM15E102J	CAPACITOR, FXD, SILVERED MICA 1000 pf ±5%, 500 vdc	1	02799
R1*, R2*	9855-4A-750K ±25PPM-1%	RESISTOR, FILM, 750k ohms ±1%, 1/2w	2	65092
R3, R4	CD1/2MR-220K	RESISTOR, FXD, FILM, 200k ohms ±1%, 1/2w	2	06228
R5		RESISTOR, FXD, COMP, 470k ohms ±5%, 1/2w	1	44655
R6, R24, R37		RESISTOR, FXD, COMP, 1 megohm ±10%, 1/2w	3	44655
R7		RESISTOR, FXD, COMP, 680 ohms ±10%, 1/2w	1	44655
R8, R9	CD1/2MR-10K	RESISTOR, FXD, FILM, 10k ohms ±1%, 1/2w	2	06228
R10, R15, R18, R32		RESISTOR, FXD, COMP, 1k ohms ±10%, 1/2w	4	44655
R11, R12	RH-5-10K	RESISTOR, FXD, WW, 10k ohms ±1%, 5w	2	91637
R13		RESISTOR, FXD, COMP, 2.2 megohms ±10%, 1/2w	1	44655
R14		RESISTOR, FXD, COMP, 330 ohms ±10%, 1/2w	1	44655
R16	CD1/2MR-75K	RESISTOR, FXD, FILM 75k ohms 1%, 1/2w	1	06228
R17	CD1/2MR-604K	RESISTOR, FXD, FILM, 60k ohms ±1%, 1/2w	1	
R19, R26, R33, R39	CD1MR-49.9K	RESISTOR, FXD, FILM, 49.0k ohms ±1%, 1w	4	06228
R20, R31	1001826	POTENTIOMETER, COMP, 10k ohms ±20%, 1/2w	2	04746
R21, R34	CD1/2MR-40.2K	RESISTOR, FXD, FILM, 40.2k ohms ±1%, 1/2w	2	06228
R22, R23 R35, R36	CD1/2MR-100K	RESISTOR, FXD, FILM, 100k ohms ±1%, 1/2w	4	06228
R25, R38	CD1/2MR-1.5K	RESISTOR, FXD, FILM, 1.5k ohms ±1%, 1/2w	2	06228
R27, R40		RESISTOR, FXD, COMP, 68k ohms ±10%, 2w	2	44655

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
R28, R41	CD1/2MR-30K	. RESISTOR, FXD, FILM, 30k ohms ±1%, 1/2w	2	06228
(OSC. 2 only)				
R29	CD1/2MR-100K	. RESISTOR, FXD, FILM, 100k ohms ±1%, 1/2w	1	06228
R30	CD1/2MR-200K	. RESISTOR, FXD, FILM, 200k ohms ±1%, 1/2w	1	06228
(OSC. 3 only)				
R29, R30	CD1/2MR-100K	. RESISTOR, FXD, FILM, 100k ohms ±1%, 1/2w (must be matched within 0.25%)	2	06228
RT1	670001	. RESISTOR, THERMAL	1	04746
TP1	276-1564-G4	. JACK, TIP, red	1	81095
XV1 thru XV4	RA9A	. SOCKET, ELECTRON TUBE	4	00656
	3002112	. PRINTED CIRCUIT BOARD	1	04746
	PARTS PECULIAR TO OSC. 2 AND 3, 60-CPS ±.1%			
	4002192-1	Main Assy, Osc. 2	1	04746
	4002193-1	Main Assy, Osc. 3	1	04746
	NOTE			
	** indicates that component is part of tube V1 filament d-c power circuit provided in 60-cps model of oscillator only.			
C1**	BR-3000-15	. CAPACITOR, FXD, ELEC, 3000 μf, 15 wvdc	1	14655
CR1**	SC-4	. SEMICONDUCTOR DEVICE, DIODE	1	14099
R2**	RH-5-0.5	. RESISTOR, FXD, WW, 0.5 ohm ±3%, 5w	1	91637
	4002152-1	P.C.B. Assy, 2-Phase Oscillator	1	04746
	4002149-1	P.C.B. Assy, 3-Phase Oscillator	1	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E92J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf, N750	1	05162
C17	CM15E682J	. CAPACITOR, FXD, MICA, 6800 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-499K ±25PPM-1%	. RESISTOR, FXD, FILM, 499k ohms ±1%, 1/2w	2	65092
	PARTS PECULIAR TO OSC. 2 AND 3, 100-CPS ±.1%			
	4002192-7	Main Assy, Osc. 2	1	04746
	4002193-7	Main Assy, Osc. 3	1	04746

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 2 AND 3, 100-CPS ±.1% (continued)		
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf, N750	1	00656
C17	CM20D392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 120-CPS ±.1%		
	4002192-8	Main Assy, Osc. 2	1	04746
	4002193-8	Main Assy, Osc. 3	1	04746
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf, N750	1	00656
C17	CM20E332J	. CAPACITOR, FXD, MICA, 3300 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 200-CPS ±.1%		
	4002192-9	Main Assy, Osc. 2	1	04746
	4002193-9	Main Assy, Osc. 3	1	04746
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 220 pf N750	1	00656
C17	CM20E202J	. CAPACITOR, FXD, MICA, 2000 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-147K ±25PPM-1%	. RESISTOR, FXD, FILM, 147k ohms ±1%, 1/2w	2	65092

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 2 AND 3, 240-CPS ±.1%		
	4002192-10	Main Assy, Osc. 2	1	04746
	4002193-10	Main Assy, Osc. 3	1	04746
	4002149-7	P.C.B. Assy, Main Oscillator	REF	04746
C1	CM20E502J	. CAPACITOR, FXD, MICA, 5000 pf ±5%, 300 wvdc	1	02799
C3	CM20E392J	. CAPACITOR, FXD, MICA, 3900 pf ±5%, 300 wvdc	1	02799
C4	CC36UJ221J	. CAPACITOR, FXD, CERAMIC, 200 pf N750	1	00656
C17	CM20E162J	. CAPACITOR, FXD, MICA, 1600 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-124K ±25PPM-1%	. RESISTOR, FXD, FILM, 124k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 500-CPS ±.1%		
	4002192-11	Main Assy, Osc. 2	1	04746
	4002193-11	Main Assy, Osc. 3	1	04746
	4002149-7	P.C.B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ240G	. CAPACITOR, FXD, CERAMIC, 24 pf N750	1	00656
C17	CM20D751J	. CAPACITOR, FXD, MICA, 750 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-590K ±25PPM-1%	. RESISTOR, FXD, FILM, 590k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 800-CPS ±.1%		
	4002192-3	Main Assy, Osc. 2	1	04746
	4002193-3	Main Assy, Osc. 3	1	04746
	4002149-7	P.C.B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	831XR5240K	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	05162
C17	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-374K ±25PPM-1%	. RESISTOR, FXD, FILM, 374k ohms ±1%, 1/2w	2	65092

TABLE 5-2. PARTS LIST FOR OSC. 2 AND 3, 400-CPS ±.1% (continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	MFR CODE
		PARTS PECULIAR TO OSC. 2 AND 3, 1000-CPS ±.1%		
	4002192-5	Main Assy, Osc. 2	1	04746
	4002193-5	Main Assy, Osc. 3	1	04746
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21J240G	. CAPACITOR, FXD, CERAMIC, 24 pf, N750	1	00656
C17	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-294K ±25PPM-1%	. RESISTOR, FXD, FILM, 294k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 2000-CPS ±.1%		
	4002192-6	Main Assy, Osc. 2	1	04746
	4002193-6	Main Assy, Osc. 3	1	04746
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E501J	. CAPACITOR, FXD, MICA, 500 pf ±5%, 500 wvdc	1	02799
C3	CM15E391J	. CAPACITOR, FXD, MICA, 390 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ240G	. CAPACITOR, FXD, CERAMIC, 24 pf N750	1	00656
C17	CM15E201J	. CAPACITOR, FXD, MICA, 200 pf ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-150K ±25PPM-1%	. RESISTOR, FXD, FILM, 150k ohms ±1%, 1/2w	2	65092
		PARTS PECULIAR TO OSC. 2 AND 3, 4000-CPS ±.1%		
	4002192-12	Main Assy, Osc. 2	1	04746
	4002193-12	Main Assy, Osc. 3	1	04746
	4002149-7	P. C. B. Assy, Main Oscillator	REF	04746
C1	CM15E101J	. CAPACITOR, FXD, MICA, 100 pf ±5%, 500 wvdc	1	02799
C3	CM15E820J	. CAPACITOR, FXD, MICA, 82 pf ±5%, 500 wvdc	1	02799
C4	CC21UJ500G	. CAPACITOR, FXD, CERAMIC, 5 pf, N750	1	00656
C17	CM15E101J	. CAPACITOR, FXD, MICA, 100 pf, ±5%, 500 wvdc	1	02799
R1, R2	9855-4A-374K ±25PPM-1%	. RESISTOR, FXD, FILM, 374K ±1%, 1/2w	2	65092

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS CORPORATION will service, replace, or adjust any defective part of parts, free of charge, when the instrument is returned to the Company freight prepaid, and when examination reveals that the fault has not occurred because of misuse or abnormal conditions of operation. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALICO will submit an estimate for such charges before commencing repair if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALICO or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or shipping instructions will be furnished. If shipment is indicated, forward the instrument, freight prepaid, to the factory or to the authorized repair station indicated in the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. CALICO will advise the disposition to be made of the equipment and arrange for repair or replacement. Please include model number and serial number when referring to the instrument.

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